11-18-1994

SR-94-95-(25)132(ASCR)

Marshall University

ACADEMIC STANDARDS AND CURRICULA REVIEW COMMITTEE RECOMMENDATION

SR-94-95-(25)132(ASCR)

To approve the SCIENCE LITERACY PROPOSAL, attached.

RATIONALE:

FACULTY SENATE PRESIDENT:

APPROVED BY SENATE: Bertram W Gross DATE: 11/18/94

DISAPPROVED BY SENATE: _____ DATE: _____

UNIVERSITY PRESIDENT:

APPROVED: _____ DATE: 11-18-94

DISAPPROVED: _____ DATE: _____

COMMENTS:

_____

_____

_____

_____

_____

SCIENCE LITERACY PROPOSAL

The Proposal

1. Beginning in fall of 1995, students entering Marshall University baccalaureate degree programs must include 4 hours of integrated science (ISC) coursework within the science requirement of their college. Students in the College of Science, School of Nursing, or Dietetics Program are exempted from the ISC requirement.

2. All Students must successfully complete a mathematics course above MTH 120 (excluding MTH 400 & MTH 401).

3. All students will be required to satisfy their mathematics requirement before enrolling in ISC courses.

4. The ISC Committee, which will consist of the College of Science Curriculum Committee and one representative from each of the other colleges, will recommend courses for the ISC designation and will oversee their implementation.

Components of the Proposal

I. Origin of the Proposal

This report originated in the Science Literacy Subcommittee of the Curriculum Task Force. The members of the subcommittee are: Daniel Babb, Richard Bady, Michael Little, Nicola Orsini, and Judith Silver (Chair). Our recommendations are the result of weekly meetings throughout both terms of Summer 1995. Faculty members who met with our subcommittee include Alan Gould, Sarah Denman, Carolyn Karr (Chair of the Curriculum Task Force), Marcia Harrison (Chair of the COS Curriculum Committee), COS department chairs, and other faculty as invited by COS chairs.

II. The Need for Science Literacy

America Does Not Compare Well in General Science Education

Science literacy is a critical need in American education today. According to a recent study, only 7% of American adults qualify as being scientifically literate, including only one in five Americans who earned a baccalaureate (but not a graduate) degree. American students ranked last in scientific literacy, behind students in all other industrialized countries. ("Public" 1992)

Science for All Americans, a report produced by the American Association for the Advancement of Science, says it this way:

"Scientific literacy -- which embraces science, mathematics, and technology -- has emerged as a central goal of education. Yet the fact is that general scientific literacy eludes us in the United States. A cascade of recent studies has made it abundantly clear that by both national standards and world norms, U.S. education is failing too many students -- and hence failing the nation. By all accounts, America has no more urgent priority than the reform of education in science, mathematics, and technology." (National 1989)

Why Graduates Need to be Literate In Science

College graduates who are classified as scientifically illiterate handicap themselves for some or all of the following reasons: An alarmingly high percentage of them are unable to enter the technological workforce due to lack of scientific skills. Many are scientifically illiterate consumers. Many are unable to discriminate between science and pseudoscience. Many are unable to vote intelligently on public policies relating to science or technology. And, many do not understand scientific terms and concepts that appear in the media.

What Science Literacy Is

Our desire is that all graduates of Marshall University have the necessary mathematical and scientific skills for professional advancement and that they be literate in science. The National Council on Science and Technology Education -- a distinguished group of scientists and educators appointed by the American Association for the Advancement of Science, defines scientific literacy in the following general terms (National 1989):

- Being familiar with the natural world and recognizing both its diversity and its unity
- Understanding key concepts and principles of science
- Being aware of some of the important ways in which science, mathematics, and technology depend upon one another
- Knowing that science, mathematics, and technology are human enterprises and knowing what that implies about their strengths and limitations
- Having a capacity for scientific ways of thinking
- Using scientific knowledge and ways of thinking for individual and social purposes

Concerns at Marshall University

The Science Literacy Subcommittee is particularly concerned with the courses Marshall University offers to non-science majors. We want our students to be familiar with more then one branch of science and we would like our science courses to be as relevant as possible to students' lives. We recommend combining several scientific disciplines into single courses centered around issues, courses which will also give students an opportunity to engage in scientific research. We have chosen to designate such courses as Integrated Science (ISC). The high priority for these is reflected in the following challenge by Dr. Gilley:

"As we move forward some new courses will have to be developed, especially in the area of scientific literacy where classes such as 'Great Ideas in Science'

tie together, as they are in nature, the essentials of chemistry, biology, geology and physics, among other disciplines." (Gilley 1994)

It is worth noting that interdisciplinary science courses for first and second year college students are now a high priority with the National Science Foundation and funds are available for the development of such courses. (Division 1993) The West Virginia Public School System has already adopted an integrated science approach through grade 10. In just three years, some of these students will be entering college and their expectations and preparation will fit nicely with the proposed ISC courses.

III. Science Recommendations

A. Integrated Science

New Courses

New interdisciplinary science courses will be offered beginning in Fall 1995 and will carry an ISC (Integrated Science) designation rather than BSC, CHM, GLY, PHY, or PS. It is our desire that these courses expose all non-science majors to some of the important scientific ideas in at least two of the traditional scientific fields and that each student will be given opportunity to understand scientific methodology by being involved in their own research project. We recommend that enrollment be limited to 48 in lecture sections and 24 in laboratory sections.

Monitoring Body

An Integrated Science Committee will be formed in the spring of 1995 to approve and monitor ISC courses. The ISC Committee will consist of the College of Science Curriculum Committee plus one faculty representative from each of the other colleges. We recommend that an ISC coordinator be appointed to direct the ISC Committee and assist in implementing ISC courses. The duties of the ISC Committee will be as follows:

1. To approve new courses for the ISC designation. (Courses submitted in fall 1994 will only require approval of the COS Curriculum Committee before being sent to the Academic Standards and Curricular Review Committee.)

2. To ensure that a sufficient number of ISC courses are offered to meet student needs and to give choice options.

3. To approve instructors for ISC courses.

4. To monitor ISC courses in order to assure that ISC guidelines are followed.

Effects on Staffing

It is recommended that ISC course offerings be at the 200-level and that students satisfy their mathematics requirement (or have a Math ACT score of at least 27) before enrolling in any ISC course. Projections by the Academic Affairs Office indicate that this will allow class sizes in ISC courses to be reduced without hiring additional faculty. The number of lecture sections and laboratory sections will remain approximately the same as currently offered.

The Integrated Science Committee will use the following guideline in determining what courses will receive the ISC designation.

Template for Integrated Science (ISC) Courses

1. *The course must be centered around "issues".*

2. *Each issue must:*
   a. *involve more than one scientific discipline*
   b. *require readings other than those from a text*
   c. *involve the answering of some "question" or "questions"*
   d. *involve the student in some sort of scientific inquiry, i.e. research that will produce new information to the student*

3. *Each student research project must be discussed in a "scientific paper". The paper should be constructed according to an accepted scientific format.*

4. *Each issue must be linked to individual and societal conditions, i.e. the consequences of this scientific work should be considered. This consideration should involve:*
   a. *the differentiation between empirical data and inference*
   b. *the use of empirical data as evidence*
   c. *the use of evidence to support a position in an argument*

5. *The course must be either team taught by instructors from more than one discipline or taught by an instructor who has demonstrated proficiency in more than one discipline*

B. Science Requirement

All students must include 4 hours of integrated science (ISC) coursework within the science requirement of their college. Students in the College of Science, School of Nursing, or Dietetics Program are exempted from the ISC requirement.

It is the feeling of the Science Literacy Subcommittee that COS majors will, by the nature of their chosen fields, be sufficiently literate in science. Even mathematics and computer science majors study science applications within their respective departments. In addition, the COS currently requires majors to take 12 hours of science in two different fields. Nursing students currently take 18 hours of science at the 200-level and dietetics majors must complete at least 26 hours of 200-level science.

We recommend that the ISC Committee evaluate the success of the ISC courses by Fall 1999. If the evaluation is positive, it would be our hope that in the future at least 8 hours of the science requirements be satisfied by ISC courses.

IV. The Need for Mathematics

Math is a Tool for Science

Math is a key ingredient in the AAAS definition of science literacy. (See p. 3) Facility in mathematics is particularly useful in understanding physical sciences such as chemistry and physics. For example, logarithms are the basis for Ph and Richter scales. Most, if not all, ISC courses will contain some physical science. In addition, most courses will involve data analysis which will require some competency in mathematics. (See part 4b in the definition of ISC courses.) The Science Literacy Committee thus recommends that all students satisfy a minimum mathematics requirement before taking ISC courses.

A recent report by the Office of Institutional Research emphasizes the high correlation between Math ACT scores and success in 100-level science courses. (See Appendix A.) Although it is advantageous for individual students to take as much math as possible before entering any science course, this must be balanced by the positive effects of taking some science during their freshman year. Thus, the Science Literacy Committee feels that math prerequisites for all science courses except ISC be left to the discretion of the individual departments.

Almost Every Career Uses Some Mathematics.

Aside from being a foundation for success in science classes, mathematical skills will also provide our students with increased employability. *Skills 2000, the West Virginia Employability Survey* identifies 11 skill levels needed by West Virginia industries in the year 2000. (Johnson, 1991) The fourth one is: "Greater mathematical skills. Most positions will require some algebra." When employers were asked what particular subject matter or skill areas needed strengthening in order for individuals to be employable in the near term future, "the resounding response was mathematics and science." By the year 2000, the U.S. economy is expected to create more than 21 million new jobs, most of which will require both postsecondary education and the use of mathematics. (Committee 1990) Consider the following quotations from sources in the business world.

"Students often ask me what to take in school...my answer?...follow your natural instincts but take lots of math!" *Thomas E. Dunham, Vice President and General Manager at General Electric*

"Just as evolutionary niches inevitably disappear, so do careers that cannot change with the times. So how does someone prepare for such an unpredictable future? The key is to learn how to think, and be able to adapt to new challenges. This is why I believe that mathematics is so valuable as an academic background." *Edward F. Preston, Systems Engineer at the MITRE Corporation*

Mathematics is Predicted to be a Greater Need in the Future

Consider the following quotations from the national action plan presented by the MS2000 Committee of the National Research Council after a three year study to revitalize undergraduate mathematics education (Committee 1991).

- Mathematics is a science of patterns that is useful in many areas. Indeed, the most rapid areas of growth in applications of mathematics have been in the social, biological, and behavioral sciences. Financial analysts, legal scholars, political pollsters, and sales managers all rely on sophisticated mathematical models to analyze data and make projections, Even artists and musicians use mathematically based computer programs to aid in their work. No longer just a tool for the physical sciences, mathematics is a language for all disciplines.

- More than ever before, Americans need to think for a living; more than ever before, they need to think mathematically.

- Literacy and numeracy -- that is, proficiency in language and in mathematics -- are the primary sources of strength and versatility in school education. Schools and colleges will have to meet goals now widely held to be unattainable.

- The degree of facility with mathematics formerly required only of those preparing for scientific careers is now an essential ingredient in the foundation for working careers in the information age.

- [Mathematics must be seen as] a pump rather than a filter in the educational pipeline to insure that students of many different interests benefit from university study of mathematics.

V. Mathematics Recommendations

Rationale

Science instructors should not have to take time out of a science lecture to teach basic mathematics techniques. Thus, it is our recommendation that all students be required to take a college level mathematics course before enrolling in any ISC course. In selecting the level of mathematics to require, we wanted to conform with practices at other universities. It would be a mistake for Marshall University to allow students to use Intermediate Algebra (MTH 120) or a lower level course, to satisfy their mathematics requirement. Many universities, such as WVU and the University of Kentucky for example, do not give any college credit for intermediate algebra classes. We feel that, while many such institutions are now requiring a math course above College Algebra (See Appendix B.), requiring one course above Intermediate Algebra is a realistic approach for Marshall University. We recommend the following:

Mathematics Requirement

All Students must successfully complete a mathematics course above MTH 120 (excluding MTH 400 & MTH 401). With the exception of students in the College of Science, School of Nursing, or Dietetics Program, individuals with Math ACT scores lower than 19 are also required to take the Fall 1995 version of MAT 097 (Developmental Algebra). A placement test option will be available.

What About MTH 110?

The current mathematics course for liberal arts majors (MTH 110) requires only a Math ACT score of 16. The College of Science feels that it is not sufficient preparation for taking ISC coursework. In addition, most colleges in West Virginia have higher prerequisites for mathematics courses for liberal arts majors. (See Appendix B.)

To respond to the need for a college-level math course for non-science majors, the mathematics department will offer a new course, MTH 121, which will emphasize practical applications of mathematics used in the everyday world. The content of this course (Appendix C) is designed to provide some of the job skills employers consistently tell us they need. Enrollment will be limited to 30 students per section to allow more interaction between the teacher and students. The prerequisite for MTH 121 will be a Math ACT of 19 or MTH 120 or MAT 097 taken in Fall 1995 or later. MTH 110 will eventually be phased out as demand drops.

MAT 097 Will be Changed for Fall 1995

The current prerequisite for MTH 120 is a Math ACT of 17 or MAT 097. MAT 097 will be revised for Fall 1995 and will require a Math ACT of 14. This new version of MAT 097 will consist of 5 contact hours for which the student will receive 4 credit hours. It will be offered by the Community & Technical College and will cover a few intermediate algebra topics. The graduation requirement will be increased by 4 hours for students who complete MAT 097. MAT 097 will not satisfy the math requirement in any program of study but will prepare a student for MTH 121.

What About MTH 120?

MTH 120 is purely an algebra class and currently requires a Math ACT of at least 17. If it had some probability and statistics it would provide sufficient background for ISC courses. Thus a new course, MTH 123, will be created to combine probability and statistics into MTH 120 course content. Some of the traditional MTH 120 content will have to be deleted in order for this new version to remain a 3 hour course. This can be accomplished by making the prerequisites for MTH 123 higher than those for MTH 120.

We recommend a prerequisite for MTH 123 of either a Math ACT of 19 or the Fall 1995 version of MAT 097. Enrollment must be limited to 30 students per section. We expect demand for MTH 120 to drop and that MTH 120 may eventually be replaced entirely with MTH 123. At that time every course offered

by the mathematics department (except MTH 400 & 401) would satisfy the mathematics requirement.

Effects on Staffing

We recommend that mathematics prerequisites be strictly enforced starting in Fall 1995. It is our belief that a student who has the necessary prerequisites will find a math course much more enjoyable than a student who does not have adequate background. Enforcing prerequisites should also prevent the repeated recycling of students who take courses for which they are not prepared, thus allowing the math department to reduce the size of MTH 121 classes to 30. Students with Math ACT scores less than19 will need to take an additional math course or courses, but these should be covered by the Community & Technical College.

In Fall 1993, for example, there were 1553 students entering baccalaureate programs at Marshall University. (McGuffey 1994) If all of these students registered for MTH 121 or MTH 123, that would require 52 sections of 30 students each. In actuality, the mathematics department offered 62 sections of either MTH 110 or MTH 120 in AY 1993/1994 and those were sections of 40 students each. If the recycling rate for these math classes can be reduced to under 20%, the math department could cut class sizes to 30 in both MTH 121 & MTH 123 and still only need to offer a total of 62 sections.

Bibliography

Committee on the Mathematical Sciences in the Year 2000. "Everybody Counts". Notices of the American Mathematical Society. March 1989.*

Committee on the Mathematical Sciences in the Year 2000. "A Challenge of Numbers". Notices of the American Mathematical Society. May/June 1990.*

Committee on the Mathematical Sciences in the Year 2000. "Moving Beyond Myths". Notices of the American Mathematical Society. July/August 1991.*

Division of Undergraduate Education. "Course and Curriculum Development Program". Program Announcement and Guidelines. National Science Foundation. 1993.

Gilley, J. Wade. "Do You Think I'll Ever Get a Job in My Field?" Parthenon, March 11, 1994.

Johnson, Ann and Kroesser, Hazel. Skills 2000, West Virginia Employability Survey. West Virginia Development Office. September 1991.

McGuffey, Michael. "Persistence Rates, All First-time Freshmen". Office of Institutional Research, Marshall University, 1994.

Michel, F. Curtis. "Science Literacy at the College Level". Physics Today. January 1993.

"Public Understanding of Science". AAALAC Communique, Winter 1992.

National Council on Science and Technology Education. "Science for All Americans". Project 2061. American Association for the Advancement of Science. 1989.

Stinson, Stephen. "Causes and Effects of Scientific Illiteracy Defined and Explored". Chemical & Engineering News. March 14, 1994.

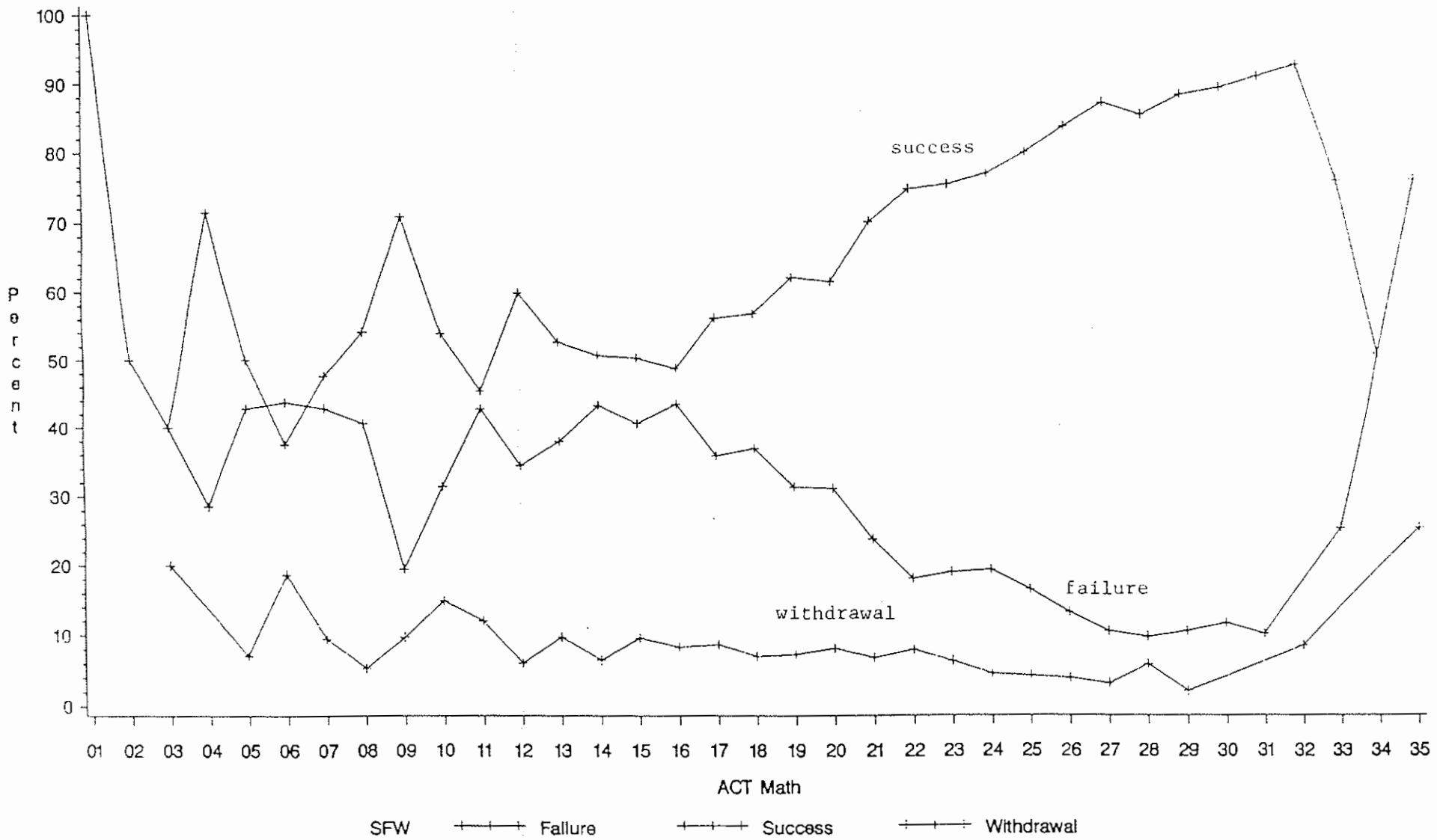
Stork, David G. "Teach Nonscience Majors 'Real World' Physics". Letter to the Editor in Physics Today. May 1994.

* "Everybody Counts", "A Challenge of Numbers", and "Moving Beyond Myths" are available in booklet form from the National Academy Press.

APPENDIX A

Success/Failure/Withdrawal

Percent by ACT Math Score
BSC 104/105, GLY 110, and PS 109/110
Fall 1991 to Spring 1994



Office of Institutional Research

Calculations for ACT Math scores below 13 or above 32 had low sample size.

APPENDIX B: MATHEMATICS REQUIREMENTS AND PREREQUISITES

All Institutions Checked	General Undergraduate Math Requirement
Adelphi	9 hrs. in math and/or science
Florida State	College Algebra plus one higher
Marshall (current)	none
Marshall (recommended)	3 hrs. above Intermediate Algebra
University of Georgia	10 quarter hrs. (6.7 sem. hrs.) math
University of Kentucky	College Algebra plus calculus or College Algebra, statistics, & logic

All Institutions Checked	Prerequitsites for Math for Liberal Arts
Concord College	ACT 17, h.s. Algebra I plus one higher
Fairmont	Math ACT 19, Algebra I plus one higher
Marshall (current)	Math ACT 16 or college elementary algebra
Marshall (recommended)	Math ACT 19 or college intermediate algebra
Ohio University	h.s. Algebra I, geometry, Algebra II
WV Tech	Math ACT 21, ACT 17, Alg. I plus one higher
WV State College	ACT 17, Math ACT 23 or C in college int. alg. (This course is a 6 hr. sequence)
WVU	ACT 19 and placement exam

Subject	Marshall University Course Number
Elementary Algebra	MAT 097
Geometry	MAT 098
Intermediate Algebra	MTH 120
College Algebra	MTH 130
Math for Liberal Arts	MTH 110 (current) MTH 121 (recommended)
Statistics	MTH 225

APPENDIX C: NEW COURSE INFORMATION FOR MTH 121

Title: Concepts and Applications of Mathematics

Credits: 3

Course Description: A survey of several branches of mathematics and their uses in our society.

Prerequisites: Math ACT 19 or MTH 120 or Fall 1995 version of MAT 097

Course Outline:

Critical Thinking
- Estimations
- Problem solving skills

Logic
- Valid arguments
- Circuits

Real Numbers
- Proportions
- Sequences

Algebra
- Manipulation of formulae
- More problem solving

Consumer Mathematics
- Mortgages
- Compound Interest

Probability
- Genetics
- Expected value

Statistics
- Data organization
- Data analysis
- Normal distributions

Geometry
- Fractals
- Computer graphics